

**A gynandromorphous speckled bush-cricket, *Leptophyes punctatissima* (Bosc, 1792) [Orthoptera: Phaneropteridae], from Germany**

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**Abstract**

In mid-August 2012, an adult gynander of the speckled bush-cricket, *Leptophyes punctatissima* (Bosc, 1792), was sampled in Jena/Thuringia. Externally, it is a nearly perfect half-sider, with normal male characters on the left and female characters on the right side. In the gynander the male pronotum, tegmen and subgenital plate as well as the female tegmen are slightly longer and the ovipositor (valves) shorter than in normal individuals. Internally, besides a full midgut several male accessory glands but no ovary structures were detected. From the original descriptions of gynanders of European Tettigonioidea (24 species in 3 families) aspects of sexual left/right-expression, sexual behaviour, and formation of inner reproductive organs are reviewed.

**Zusammenfassung**

Mitte August 2012 wurde in Jena/Thüringen eine gynandromorphe Imago der Punktierten Zartschrecke, *Leptophyes punctatissima* (Bosc, 1792), gefunden. Der äußeren Erscheinung nach ist es ein fast perfekter Halbseitenzwitler mit Männchen-Merkmalen auf der linken und Weibchen-Merkmalen auf der rechten Seite. Im Vergleich zu normalen Individuen der Region (7 ♂♂, 5 ♀♀) sind beim Gynander Pronotum, Tegmen und Subgenitalplatte der männlichen Hälfte sowie das Tegmen der weiblichen Hälfte etwas länger und die Ovipositorvalven etwas kürzer. Im Abdomen fanden sich neben einem gut gefüllten Mitteldarm zwar akzessorische Drüsen (♂), aber keine Ovariolen. Aus den Originalbeschreibungen von Gynandern europäischer Tettigonioidea (24 Arten in 3 Familien) werden Aspekte der sexuellen Links/Rechts-Ausprägung, des Sexualverhaltens und der Ausbildung innerer Geschlechtsorgane recherchiert.

**Introduction**

In Orthoptera, gynandromorphous individuals are found extremely rarely, often as unique occasions during an orthopterist's life, so that every specimen hitherto known has been worth to be published and illustrated. Relevant papers were listed repeatedly over the years, so by KHEIL (1914/15), CAPPE DE BAILLON (1924), DUMORTIER (1962), and UVAROV (1966, Caelifera). Extensive reviews considering Orthoptera were already given by HEWITT (1979, later completely neglected) and NICKLE (1983), whereas gynanders in arthropods including Orthoptera were summarized recently by NARITA et al. (2010), listing gynanders and intersexes in more than 300 arthropod species, most of them insects. Worldwide at least 56 Orthoptera species (and hybrids) – 32 Ensifera and 24

Caelifera – are mentioned. This might be somewhat incomplete, because the widely scattered papers in six languages sometimes are difficult to trace. Considering only cases of European origin, gynanders from 24 Tettigonioidea (compare Table 2), 10 Acridoidea and few Grylloidea species are known (NICKLE 1983, NARITA et al. 2010).

Of the speckled bush-cricket, *L. punctatissima*, hitherto three gynandromorphous individuals were described, two of them sampled about a century ago in Belgium (1915) and ?France (1924 – where the species is widespread) and studied in great detail by CAPPE DE BAILLON (1924, 1932), and one of them sampled in 1977 in Corsica and recently described by MASSA (2010). The present notice focuses on the external characters of a recently sampled gynandromorphous specimen embedding the results into the hitherto known facts of European Tettigonioidea gynanders.

### Origin and measurement

The gynandromorphous adult speckled bush-cricket was sampled on 13.VIII. 2012 in Jena/Thuringia in a house-garden on a WSW-exposed slope of the Saale-river valley (50°55'38" N, 11°36'26" E; leg. F. Creutzburg). During the determination of the already needed specimen it was recognized as a gynander, while for taking photos and measurements it was re-prepared. Finally, the needed gynander was softened up, the abdomen cut behind the tegmina and ventrally opened to assess the inner sexual organs.

For a morphometrical comparison with normal individuals of the region, a total of seven adult males and five females were available, sampled between 1979 and 2010 in the Central Saale-river valley around Jena (coll. Köhler). The needed individuals, including the gynander, were measured (by G.K.) under a stereomicroscope (SM XX, Carl Zeiss Jena) by means of an ocular micrometer, using 8× (postfemur) and 12,5× enlargements (pronotum, tegmina, subgenital plate and ovipositor length). The lengths of pronotum and tegmina (visible part) were measured from the dorsal side, of subgenital plate and ovipositor (up to the final tip) from the lateral side, without considering the curved structures. The body length has not been measured because of the variable shrinking in the dried specimens.

### Description and comparison

The gynander of *L. punctatissima* here described, is a nearly perfect half-sider with male characteristics on the left and female ones on the right side (Fig. 1a). Accordingly, the male side shows a slightly shorter pronotum, a larger tegmen (ala not considered), a half subgenital plate (divided at the keel), a slightly longer supraanal plate, and a slightly shorter left hindleg. The female side has a somewhat longer pronotum, a shorter tegmen, a half ovipositor, a shorter supraanal plate, and slightly longer hindlegs (Table 1). Therefore it dorsally looks irregularly formed and slightly curved. In addition, the dorsal colouration of the abdomen consists of a half brown band on the left side (♂) and a dense dark dotting on the right (♀) side (Fig. 1a, b).

Table 1: Morphometrical parameters [lengths in mm; median (min-max)] of a gynander (half-sider) of *Leptophyes punctatissima* in comparison with normal males and females from nine localities of the Saale-river valley (coll. Köhler).

Sex	Pronotum	Tegmen	Postfemur	Subgenital plate	Ovipositor
<b>Gynander</b>					
♂ (left)	2.4	3.5	13.6	3.6	---
♀ (right)	2.7	1.9	14.9	---	6.4
<b>Normal</b>					
♂ (n=7)	2.2 (2.1-2.3)	2.9 (2.7-3.1)	13.5 (12.3-13.8)	3.5 (3.4-3.5)	---
♀ (n=5)	2.8 (2.4-3.0)	1.5 (1.4-1.5)	14.4 (13.5-15.9)	---	6.7 (6.6-7.0)

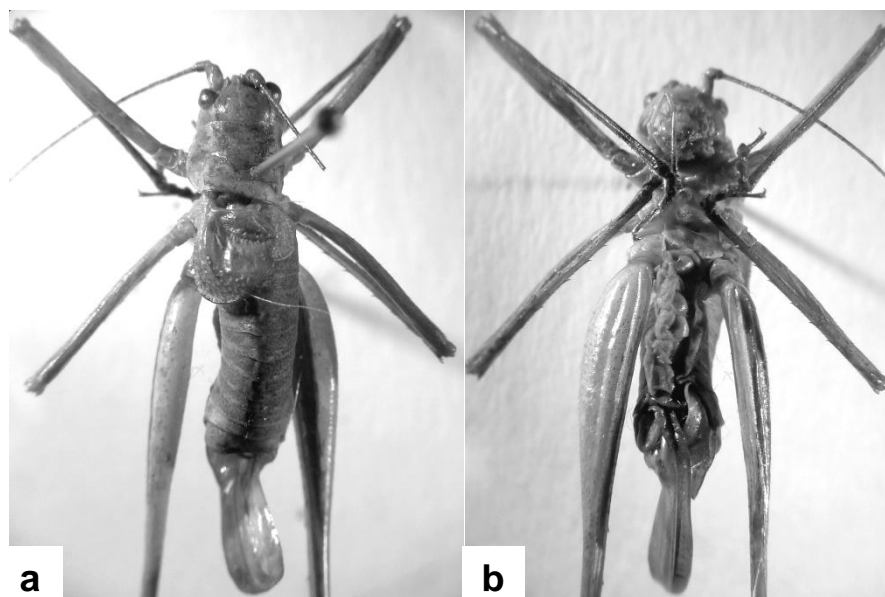


Fig. 1:

(a) From the dorsal side, the gynander of *Leptophyes punctatissima*, sampled in Jena/Thuringia, is a perfect half-sider (compare tegmina, abdomen, cerci, and sexual structures).

(b) From the ventral side, in the gynander the subgenital plate of the female side is shortened (or missing).

The male and female side of the gynander correspond perfectly to the sex-dimorphic species characteristics (e.g. HARZ 1960a), except the shortened (resp. missing) subgenital plate on the female side and a few morphometrical shifts. Compared with normal individuals, in the gynander the male pronotum, tegmen and subgenital plate are slightly longer, whereas the male postfemur is not. On the female side the tegmen is distinctly longer and the ovipositor shorter (2,4× pronotum length) than in normal individuals, whereas pronotum and postfemur are within the regional species variability range (Table 1). The half ovipositor seems complete, consisting of the three valves and showing the typical fine serration.

The abdomen contained a clumped mass with the looped mid-gut, filled with dark particles of food. The main part consisted of male accessory glands, whereas no ovary structures could be detected. According to the phenology of this species in Thuringia (adults from the end of June until the end of September – KÖHLER 2001), in mid-August normally some ovariole development should occur. In one female *L. punctatissima* a total of 37 ovarioles were counted (Samietz & Köhler, in litt.).

## Discussion

In bisexual invertebrates, individuals with male and female characters are only known from Arthropoda, and mainly from insects. But there is a considerable variability in the sexual division, ranging from nearly perfect bilateral (half-siders, referred as gynandromorphs – as in our case) over patchily distributed to uniformly mixed patterns (intersexes). The occurrence of gynanders doubtlessly stimulated the discussions about several developmental problems: formation patterns after egg fertilization, dependence of secondary from primary sexual characteristics, homology (morphological parallelism) between male/female characteristics (in the same individual), and sexual organ formation during the juvenile development (summarized by NICKLE 1983, DETTNER & PETERS 2003, and NARITA et al. 2010).

The first Orthopteran gynander was described in *Chrysochraon dispar* by BRISOUT DE BARNEVILLE (1848) about three decades before the next one in *Isophya pavelii*, the first gynander in Tettigonioidea (CHADIMA 1872, BRUNNER V. WATTENWYL 1876 – both authors described the same individual from Brunners collection). Focussing on gynanders of European Tettigonioidea, hitherto 33 individuals from 24 species of 3 families were described (Table 2). In more detail, the gynanders in their external morphology (so far described) were 20 half-siders, 10 with (often slightly) male and only three with female dominance. The left-right distribution of the sex is not equally, with male expression 12x on the left and 15x on the right side, and reversed female expression, respectively, with some variability in single character formation. In *L. punctatissima*, all four known gynanders are male on the left and female on the right side. Morphometrically, some gynanders are within the normal population resp. species range, as seen in *L. punctatissima* here described and known from the same species and *M. brachyptera* (CAPPE DE BAILLON 1924) as well as from *I. kraussii* and *I. camptoxypha* (NAGY 2004). In contrast to, the gynanders of *L. punctatissima* and *C. siculus* described by MASSA (2010) are distinctly smaller than normal specimens from corresponding regional populations.

Furthermore, there are two striking aspects: most of the gynanders are known (1) from Phaneropteridae (19 specimens in 12 species = about 7.6% of all European species in this family), and (2) from southern Europe, where about two third of all known individuals were found (Table 2). The three northern-most gynanders were sampled in Gemert/Netherlands (51.33 N, *M. brachyptera* – CAPPE DE BAILLON 1924), Jena/Thuringia (50.55 N, *L. punctatissima* – this article), and Luigne/Belgia (50.43 N, *L. punctatissima* – CAPPE DE BAILLON 1924). Despite their rarity it is also hypothesized that gynanders could occur in higher frequencies in distinct populations, as observed in *I. kraussii* (2 gynanders from 72 ind. – NAGY 2004) and *I. modesta* (3 from 47 ind. – KISS 1960). Biologically, gynandromorphous individuals must have a normal juvenile development without problems during moulting, because most of them were already found as adults. This is supported by few juvenile gynanders reared to the adult stage: *L. punctatissima* as L2 (CAPPE DE BAILLON 1932), *M. brachyptera* as L3 (CAPPE DE BAILLON 1924), *I. kraussii* as L3, and *I. camptoxypha* as L4 (both NAGY 2004).

Table 2: Gynandromorphism of wild specimens in European Tettigoniioidea (species names actualized and ordered according HELLER et al. 1998), with striking external characters. Remarks: (1) *Barbitistes yersini* and *Isophya pavelii* were afterwards described by BRUNNER VON WATTENWYL (1878 resp. 1882); (2) *Isophya camptoxypha*: gynander in F1 generation from two years diapau-sing eggs (NAGY 2004); (3) EBNER (1940, *M. brachyptera*) not considered because of the parasitizing origin of the intersex. Only original description sources are considered (\*with drawings resp. photos). L: left, R: right side of the gynander (seen from dorsally).

Family / Species	Male characters	Female characters	Reference
<b>Bradyporidae</b>			
<i>Ephippiger ephippiger</i>	both cerci; R: tegmen (with pars stridens)	L: tegmen, tubercle (rest of subgenital plate), valves R: inner valve	DUMORTIER (1962*), French Eastern Pyrenees
<i>Ephippiger e. vitium</i>	no description given	no description given	PANTEL & DE SINÉTY (1908), from own collec-tions, no locality
<i>Ephippiger terrestris</i>	both cerci, supraanal plate; R: subgenital plate	both tegmina; L: subgenital plate, valves strongly shortened	KHEIL (1914/15*), Bagnols / Dép. du Var
<i>Pycnogaster graellsii</i>	no description given	no description given	PANTEL & DE SINÉTY (1908), from own collec-tions, no locality
<i>Pycnogaster inermis</i>	L: cercus, single titillator, subgenital plate (deformed)	R: cercus, subgenital plate (reduced), valves shortened	BARRANCO et al. (1995*) Sierra Nevada / Spain
<b>Phaneropteridae</b>			
<i>Ancistrura nigrovittata</i>	R: male characters	L: female characters (valves ± deformed)	VLK (2008*), Belasica Mts. / Bulgaria
<i>Barbitistes constrictus</i>	both cerci; L: pronotum, tegmen, R: rudimentary sub-genital plate	R: pronotum, tegmen, valves rudimentary	CHLÁDEK (1968*), Volovec / Slovakia
<i>Barbitistes yersini</i>	L: subgenital plate, cercus	R: subgenital plate, valves ± shortened	BRUNNER V. WATTENWYL (1976*), Dalmatia
<i>Isophya camptoxypha</i>	R: abdominal coloura-tion, cercus	both tegmina, L: abdominal coloura-tion, valves, cercus	NAGY (2004*), e.o. W Cluj/ Transsylvania, Romania
<i>Isophya kraussii</i>	R: tegmen (shortened), subgenital plate, cercus	L: tegmen, cercus, valves	NAGY (2004*), Aggtelek NP, NE-Hungary – gyn. 1
	all characters and L: tegmen	R: tegmen only	NAGY (2004), Aggtelek NP, NE-Hungary – gyn. 2
<i>Isophya modesta</i>	R: tegmen, subgenital plate, cercus	L: tegmen, subgenital plate with stylus, valves shortened	KISS (1960*), Cluj / Romania – gyn. 1
	both tegmina and cerci, R: subgenital plate	L: valves rudimentary	KISS (1960), Cluj / Romania – gyn. 2
	all characters and R: tegmen	L: tegmen only	KISS (1960), Cluj / Romania – gyn. 3
<i>Isophya pavelii</i>	L: tegmen, subgenital plate, cercus	R: cercus, subgenital plate, valves short-ened	same speciemen descri-bed by CHADIMA (1872*) and BRUNNER V. WATTENWYL (1876*), Bosphorus/Turkey

Family / Species	Male characters	Female characters	Reference
<i>Isophya pyrenaea</i>	R: tegmen, cercus, subgenital plate	L: tegmen, cercus, valves (lower shortened)	DUMORTIER & PALY (1971*) Montpellier – Sète / France
<i>Leptophyes laticauda</i>	R: tegmen, abdominal colouration, cercus, subgenital plate	L: tegmen, abdominal colouration, cercus, valves $\pm$ deformed	FONTANA et al. (2002*) Isola Vicentina, Veneto / Italy
<i>Leptophyes punctatissima</i>	L: tegmen, ala, cercus, subgenital plate	R: tegmen, ala, cercus, valves slightly shortened	CAPPE DE BAILLON (1924*), Luvingne / Belgia
	colouration; L: tegmen, subgenital plate, cercus	R: tegmen, subgenital plate with stylus, valves slightly shortened	CAPPE DE BAILLON (1932*), ?France
	L: tegmen (intermediate), cercus, subgenital plate	R: tegmen (intermediate), cercus, valves	MASSA (2010*) Corsica
	L: tegmen, subgenital plate, hindleg	R: subgenital plate (shortened), valves, hindleg	KÖHLER & KUNERT (2013*), Jena / Thuringia, Germany
<i>Poecilimon elegans</i>	L: cercus	L/R: otherwise female characters	RAMME (1926*) Dalmatia
<i>Poecilimon orbelicus</i>	R: epiproct, cercus, subgenital plate; femur + tibia slightly longer than L; tegmen $\pm$ juvenile like	L: subgenital plate, cercus, valves; tegmen $\pm$ juvenile like	HARZ (1967*) Bistriza-valley / Bulgaria
	R: male characteristics	L: fem. characteristics (valves $\pm$ deformed)	VLK (2008*) Pirin Mts. / Bulgaria
<b>Tettigoniidae</b>			
<i>Antaxius pedestris</i>	L: tegmen, hindlegs, cercus, subgenital plate deformed	R: tegmen, hindlegs, cercus, valves shortened	GRANDCOLAS (1984*) Alpes-Maritimes / France
<i>Ctenodecticus siculus</i>	R: 10. tergum, cercus, subgenital plate	L: 10. tergum, cercus, valves	MASSA (2010*) Sicily / Italy
<i>Decticus albifrons</i>	R: testicle surrounded by ovar	L (+R): mainly female – tegmina, cerci, subgenital plate, valves (here R abnormal)	BOUDOU-SALTET (1975*) Var / S-France
<i>Decticus verrucivorus</i>	both tegmina; L: subgenital plate, cercus	R: subgenital plate deformed, cercus, valves shortened and slightly deformed	RAMME (1951*), Stăna Regale / Romania
<i>Metrioptera brachyptera</i>	both tegmina; L: subgenital plate, cercus	R: subgenital plate with stylus, valves	HARZ (1960b), Münnerstadt / Bavaria
	both tegmina; L: supraanal plate, shorter cercus, subgenital plate	R: longer cercus, tubercle (subgenital plate), valves shortened and deformed	CAPPE DE BAILLON (1924*), Gemert / NL
<i>Pholidoptera fallax</i>	both tegmina; R: cercus, subgenital plate	L: subgenital plate, cercus, valves $\pm$ shortened	RAMME (1913*), Kranjska / W-Slovenia
<i>Platycleis intermedia</i>	R: no information	L: no information	MATEOS MARTIN & PEINADO DE DIEGO (1986)
<i>Tettigonia viridissima</i>	R: translation gaps	L: cercus, valves shortened / deformed	KLAPÁLEK (1898*), Třebon / Bohemia

As adults some gynanders showed  $\pm$  normal stridulation ( $\sigma$ ,  $\phi$ ) and other elements of copulation behaviour, as observed in *M. brachyptera* (HARZ 1960b), *E. ephippiger* (DUMORTIER 1962), *I. kraussii* and *I. camptoxypha* (NAGY 2004). This mostly coincides with the internal sexual organs studied in gynanders of nine Tetrigonioidea species. In some external half-siders also internally male and female organs were separated in the same way, in others the paired testicles were on the female side covered by ovarian structures (ovotestis), and in several gynanders also well-developed ovaries resp. eggs were found. But finally, any successful reproduction of gynanders will primarily fail (if no self-fertilization) because of the incomplete (and sometimes abnormal) external reproductive organs (NICKLE 1983), and secondarily because of their considerable shorter lifetime, as observed in *I. kraussii* (NAGY 2004).

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